Freight shift from road to rail REPORT

THE SOCIO-ECONOMIC IMPACT OF A MODAL SHIFT OF FREIGHT FROM ROAD TO RAIL TO ACHIEVE MAXIMUM GREENHOUSE GAS MITIGATION IN THE TRANSPORT SECTOR

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The study was conducted by Palmer Development Group (PDG), in partnership with Camco Clean Energy (South Africa).

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Executive summary

The Department of Environment Affairs has recently completed a Mitigation Potential Analysis (MPA) for South Africa aimed at identifying priority mitigation measures which will significantly reduce greenhouse gas emissions. One of the most favourable measures, taking both the extent of mitigation of emissions and the associated social and economic impacts in to consideration is the shift of freight from road to rail. It has the potential to save almost 3 000 ktCO_2eq (0.66% of the total mitigation potential in South Africa, according to the MPA). However, DEA has retained a concern over the possible job losses caused by the road to rail freight shift, primarily as rail freight is less labour intensive. Therefore this research was commissioned to assess the impact on jobs and, more broadly, on the economy as a whole.

The quantification of the socio-economic impact of the modal transition of freight from road to rail has been undertaken through three stages of analysis:

- A projection of the freight movements throughout the country but with specific attention to movements along corridors where the opportunities for modal shifts are greatest, taking into consideration commodities which are well suited to transport by rail.
- A projection of the overall costs which will be borne by the economy during the construction of new infrastructure and the operational costs associated with the modal shift.
- Application of these costs to a socio-economic model which allows the broader economic impacts, including employment impacts, on the South African economy to be assessed.

In making projections of freight quantities, Transnet's Freight Demand Model has been used to determine the projected growth of the full range of commodities. Freight has been broken down into 74 commodity types with these grouped as follows:

- **Bulk commodities** which are generally moved in large quantities and are not suited to packaging or containerising. They can be in solid, liquid or granular forms. Examples of bulk commodities in South Africa are coal, iron ore, petroleum-based products and some forms of agricultural products (such as wheat and maize).
- **General freight** is freight which is not classified as bulk cargo. It encompasses

a very broad range of products, and is generally differentiated from bulk by being either fragile, perishable, valuable or because the volume of cargo moved is too low for it to be considered as 'bulk'. For the purposes of this study, the definition of general freight is deliberately left broad as this will allow for the greatest flexibility associated with shifting the mode of transport.

- **Break bulk** is sub-component of general freight which is loaded onto/into a mode of transportation as individual or bundled pieces. Examples of this are palletised goods, such as cement bags or processed food.

These commodity groupings line up with their relative ability to be moved via rail. Bulk freight is clearly suited to rail movement, as it is high volume and generally lower value per mass and generally has relatively fixed origin and destination points. General freight is suited to make a transition from road to rail if it flows along a corridor (with relatively fixed origin and destination points) and it is in a palletised or palletisable form. Therefore the emphasis in this study is on general freight movements along corridors.

Projections of freight movements are made based on economic growth with mass of freight movements closely correlated to economic growth (overall freight growth is assumed at a constant 0.25% less than GDP growth). Projections are made from the current year (2014) to 2050. Having these projections the second component of the analysis, the costing was undertaken using the following data:

Aspect of costing model	Road	Rail
Vehicle capital cost	Road Freight Association tables	Transnet Long Term Planning Framework
Infrastructure capital cost	South African National Roads Agency Limited Asset Management Plan, bilateral discussions & own calculations	Transnet Long Term Planning Framework
Vehicle operating cost	Road Freight Association tables	Transport Research Support, Public-Private Infrastructure Advisory Facility, World Bank (2011)

Aspect of costing model	Road	Rail
Infrastructure operating cost	SANRAL Asset Management Plan	Transport Research Support, Public-Private Infrastructure Advisory Facility, World Bank (2011)

Applying this data the, both capital and operating costs of moving freight can be calculated with the results shown in the table below:

Costs incurred per year (2014 Rbn)

	Road	Rail
Vehicle capital cost	25	2
Infrastructure capital cost	7	4
Vehicle operating cost	422	47
Infrastructure operating cost	2	

The figures above are shown in the average year, which is estimated to be the year 2032. The figures re for the Transnet (high) uptake outlook.

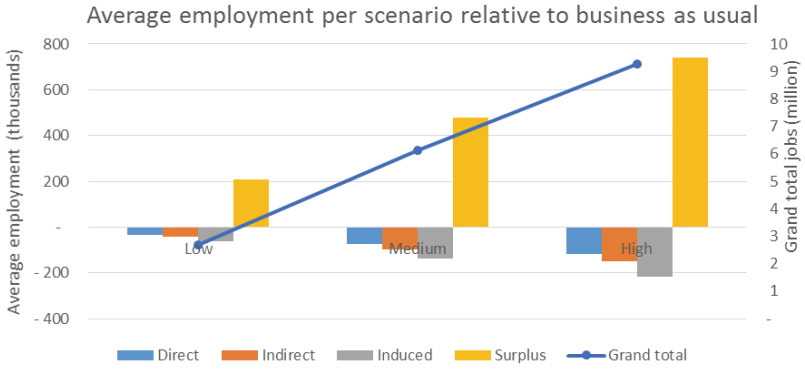
In considering costs it is notable that the emphasis of this analysis is on direct costs of moving freight. In reality customers who require freight services look at the total overall impact on their businesses of moving their goods, taking risk associated with uncertain delivery times, inventory holding costs and other non-cost factors into consideration. In excluding these 'costs', which are too complex to estimate in a study of this nature, the result is overly favours the potential for a shift to rail freight.

Turning to projections on economic and employment impacts, in order to make comparisons in terms of road to rail shifts, a base case needs to be established. For this case, the current freight makeup was projected forward, and assumed zero move from road to rail (the current relative proportions were maintained). Three different uptake outlooks were then modelled, with varying rates of freight uptake by rail. The results of these freight uptake outlooks were compared to that of the business as usual outlook. The only variable which changes between scenarios is the rate of change of freight uptake. Transnet has an aspirational upper limit of a 70% market share of general freight on corridors by the year 2043, with the medium and low uptake outlooks presenting 50% and 30% general freight corridor based market shares by 2043 respectively.

The economic modelling is aimed at assessing three sets of impacts, taking both GDP and employment changes into consideration:

- **Direct impacts** are associated with projected changes in the transport sector itself: changes in GDP and employment in the road and rail freight industries.
- **Indirect impacts** are due to backward (upstream) linkages which are caused through the changes in inputs to the transport sector through, for example, the purchase of fuel and vehicles. In modelling also include **induced impacts** associated with changes in the backward linked sectors. These backward linkages impact on sectors of the economy separate from transport. These other sectors may be affected positively or negatively depending on the change in purchases from these sectors by the transport sector.
- **Surplus impacts** are the 'forward' impact which is caused by the change in the amount of transport used (and purchased from the transport sector) by all the sectors of the economy where freight movement is required. This impact is assessed through the change in net cost transport which is effectively a change in price (for example, a lowering in price results in greater surpluses with this additional money stimulating the economy as a whole).

The results of the analysis are reported in the main body of this report in terms of GDP and employment (total labour years) changes for the full modelling period. They can be interpreted as figures per year by taking an average over the modelling period. The overall employment results from the modelling process are depicted in the figure below.



Cumulative employment by freight uptake outlook

As is evident in the graph depicted above, there is a job loss in the direct, indirect and induced industries relative to the 'business as usual' outlook. This is offset by the surplus employment which is generated as a result of the savings which are incurred due to the modal shift. The overall level of employment will improve in the economy due to the modal shift.

While it is necessary to consider the implications of direct job losses (discussed further below), this should not detract from the overall impact of the model shift on the South African economy which will benefit significantly as indicated above. Even considering the losses in the backward linked sectors such as the manufacturing of road freight vehicles and fuel, these are more than offset by benefits to households due to lower costs of goods, with the surplus available to households use to purchase goods and services in the economy as a whole and hence create jobs.

Looking at direct employment in the transport sector only it is evident that there will be job losses. These need to be related to the current situation where data is uncertain. However, based on an assessment of StatsSA (2010) and Human Sciences Research Council (2008) information, it is estimated that the current employment levels are in the region of 121 000 jobs in the freight transport sector. Of these jobs an estimated 81 000 are involved in corridor based movements.

In the average year of 2032, the business as usual scenario estimates that there will be 169 000 jobs in the corridor based movements of general freight. The model estimates a total loss of 115 000 direct job loss due to the freight modal shift, leaving an estimated employment of approximately 54 000 along corridors shifting general freight. This is a direct job loss of approximately 27 000 jobs[1]. It must be noted that these job losses would only be incurred in corridors based movements, and this is offset by substantial gains made in the freight transport sector as a whole (bulk freight and non-corridor based general movements in metros and rural areas).

The timing of potential job losses in the road freight industry also needs to be considered: this will happen gradually and it is highly unlikely that workers will need to be retrenched due to a shift of freight from road to rail. It is more likely that the trucking businesses will shift their business to other parts of the transport sector, either away from competing with rail on corridors, or moving to shorter haul intra-city movements. If retrenchment were to happen the economic surplus effect will result in greater job opportunities elsewhere in the economy. It should

[1] *Note that this is for the high freight uptake outlook, which is Transnet's aspirational position, but it may not necessarily be attainable*

also be noted that the high freight uptake by rail outlook is only aspirational at this point, and it is likely that a lower uptake will in face occur, thus there may be no direct job losses on corridor based movements.

In order to mitigate job loss in the direct and indirect sectors, there are a few approaches that could be taken:

Supplier development

Any expenditure which leaves South Africa does not benefit the country's GDP and employment levels, therefore the development of suppliers within the country should be a priority. This includes, among other:

- Construction of rail infrastructure
- Manufacturers of rail vehicles
- Manufacturers of road vehicles (both for freight and passenger vehicles)
- Industries which are involved in the backward linkages of these industries, such as the energy industry where there are many new developments currently.

Passing on of cost savings to the consumer

There is a tendency for companies to identify an area of potential profit, especially those in monopolistic situations such as Transnet. However, Transnet is in a unique position as a parastatal to ensure that the benefits of reduced logistics costs are passed on, resulting in increased disposable income for the consumer. Through doing this, there will be greater economic benefits resulting through the multiplier effect.

Supporting transport sector as a driver of the economy

Rather than see the negative possibility of job losses in the transport sector the much more important positive impact on the economy as a whole of an effective transport sector should receive attention. By increasing investment in transport infrastructure and the sectors serving it, the spin-off for the economy as a whole, including jobs, is substantial. This can occur at the same time as making the cost of freight transport lower.

Purpose of the study

The Department of Environmental Affairs (DEA), with support from the German International Cooperation (GIZ), commissioned Palmer Development Group, trading as PDG, to perform a socio-economic impact study on the potential modal shift of freight from road to rail in order to achieve maximum greenhouse gas mitigation. PDG was supported by Carbon Asset Management Company (Pty) Ltd, trading as Camco Clean Energy (South Africa) and Dr Neil Jacobs.

The purpose of this study was to provide further insight into the potential socio-economic impacts of the potential freight modal shift from road to rail. This follows from previous work done by DEA on the Mitigation Potential Analysis (MPA) which identified this modal shift in the freight sector as one of the most beneficial greenhouse gas (GHG) mitigation measures, making this a national priority of Government. However, there have been concerns about direct job losses in the road freight industry and hence this project intended to look at employment impacts in the context of broader employment and economic impacts of a projected modal shift.

Introduction

Rail transport has the potential, under the right circumstances, to provide a cost effective freight transport option, making the economy more efficient, provide access for freight and passenger movements, as well as providing an environmentally sustainable transport solution. However, rail transport has its limitations with the primary disadvantage being that it provides limited flexibility in terms of destinations located off main freight and passenger movement corridors. This is particularly significant when non-corridor movements in rural and metropolitan areas are considered (Havenga & Pienaar, 2012). Nevertheless, the opportunities for shifting freight movements from road to rail along corridors are substantial and hence the Department of Environment Affairs, assisted by GIZ, have commissioned this study which is aimed at investigating the impacts of a road to rail shift.

The study follows from the recently completed Mitigation Potential Analysis (MPA) undertaken by DEA which identified the shift of freight from road to rail as a high priority greenhouse gas mitigation measure. It has the potential to save almost 3,000 kilotons of carbon dioxide equivalents ($ktCO_2$ eq) per year by the year 2050 (approximately 0.66% of the total mitigation potential in South Africa, according to the MPA). In addition to the potential greenhouse gas mitigation effects, the MPA indicated that the modal shift also has the potential to generate employment in the economy as a whole at a relatively low cost per unit of emissions abated.

Historically, rail was the preferred method of moving freight in South Africa, but following the deregulation of the transport sector, the rail market share has progressively decreased. The investment in the rail transport infrastructure also decreased in conjunction with the liberalisation of transport in South Africa. Due to the decreased condition of rail infrastructure, there are significant challenges in promoting the most economically effective movement of freight. There is a modal imbalance between road and rail movements, which leads to an unsustainable use of road infrastructure (Havenga & Pienaar 2012). This has led to strain being put on the national fiscus due to increased capital and maintenance costs of road infrastructure, as well as strain on the private sector who are forced to use more expensive road transport as the mode of choice.

The current contribution of freight logistics to the South African economy is estimated at 13.5% of the gross domestic product (GDP) (Council for Scientific and Industrial Research, 2013). This is higher than the international average in developed countries of 8-10% of GDP. A significant contributor to this relatively

high freight contribution is the long-distance road transport market share, attributable to an extent to the fact that our largest economic centre is inland, which means larger transport effort and thus higher costs. It is also influenced by the high proportion of low value, high mass primary goods which are sensitive to logistics costs which make up a large portion of their delivered costs (Havenga, 2013).This relatively high dependence on logistics creates a relatively high exposure within South Africa to price shocks caused high reliance on imports in the transport sector, such as exchange rate and oil price changes. This exposure has been necessary though, as the efficient movement of freight is vital for growth and economic development (Harris & Anderson, 2011).

The challenge for South Africa is that even if rail were to triple the current volume of freight movements, it is estimated that road transport would need to increase by 180% in order to meet the projected freight demand levels in 2043. Therefore, if the evidently more sustainable rail freight solution is to be dominant, there will need to be a dramatic change in the modal split of freight transport (Havenga 2013). In considering the impact of such a shift on the South African economy, it is notable that the direct impact on the transport sector itself needs to be considered along with broader impacts which occur through the indirect impact associated with more efficient freight movements.

2 Background and terminology

In order for a socio-economic analysis to be performed on the freight transport sector, a better understanding of the transport sector itself is needed. This section will provide a description of the components of the sector, the terminology associated with the sector and a description of the components which are the inputs to the socio economic modelling process.

This section covers a description of the freight sector and the national freight flow model, the road and rail infrastructure necessary for freight movements, the road and rail vehicles necessary to move the freight, the socio economic model which calculates the economic impacts of freight transitions and, finally, an overview of South Africa's freight sector makeup.

2.1 The freight transport sector and the national freight flow model

Professor Jan Havenga and Professor Wessel Pienaar of the Department of Logistics at Stellenbosch University created a national freight flow model (NFFM) in order to provide information on the modal market share and freight flows in

South Africa. The primary objective of this model is to inform infrastructure policy decisions and planning, and, secondly, to provide lead and lag indicators of the performance of the freight transport network (Havenga, J H & Pienaar W J, 2012).

The NFFM methodology is covered extensively in Havenga & Pienaar (2012), with a brief summary provided here. The NFFM uses the national input-output table (I-O table) to model the supply of commodities geographically (by magisterial district). The I-O table quantifies all transactions that take place between the main economic sectors in a particular year. These transactions are monetary, which is then converted into a volumetric transaction by using commodity densities and prices. The modal split is determined by subtracting the known flows (rail, pipeline, conveyor and coastal shipping) from the calculated values.

The freight demand model (FDM) is a forward projection, using the NFFM as the base from which projections are made. It uses both tons and ton-kilometres (t.km) as units of measurement. The usage of t.km is most common in freight modelling as it is indicative of both the mass and the distance that the freight is moving.

There are three different spatial circumstances affecting the movement of freight:

- **Corridor movements** occur along a defined geographical route, typically between major metropolitan areas and ports. They are variable in length depending on their specifically identified Origin/Destination (OD) points. Examples of corridors would be the Cape Town to Gauteng and the Durban to Gauteng corridors.
- **Rural movements** are characterised by a dispersion of OD points. These are generally movements of agricultural or other primary products direct to ports or urban hubs where the goods may be processed or transferred to other modes or into corridor routes.
- **Metropolitan movements** are movements which occur within metropolitan areas. They are generally either the first or last component of a longer movement, or they can be movements between independent origin and destination points within metropolitan areas (say from warehouse to a retailer).

Another distinction which needs to be made is the differentiation of bulk commodities and general freight commodities:

- **Bulk commodities** are generally moved in large quantities. They can be in solid, liquid or granular forms. Examples of bulk commodities in South Africa are coal, iron ore, petroleum-based products and some forms of agricultural products (such as wheat and maize).

- **General freight** is freight which is not classified as bulk cargo. It encompasses a very broad range of products, and is generally differentiated from bulk by being either fragile, perishable, valuable or because the volume of cargo moved is too low for it to be considered as 'bulk'. For the purposes of this study, the definition of general freight is deliberately left broad as this will allow for the greatest flexibility associated with shifting the mode of transport.
    - **Break bulk** is sub-component of general freight which is loaded onto/into a mode of transportation as individual or bundled pieces. Examples of this are palletised goods, such as cement bags or processed food.

Three other methods are useful for categorising freight transport. These distinctions are made in Figure 1. The categories are:

- Rail friendly freight (predominately bulk freight),
- Competitive freight (freight which can move by either road or rail),
- Road friendly freight (generally perishable or valuable cargo)
- Pipeline friendly freight

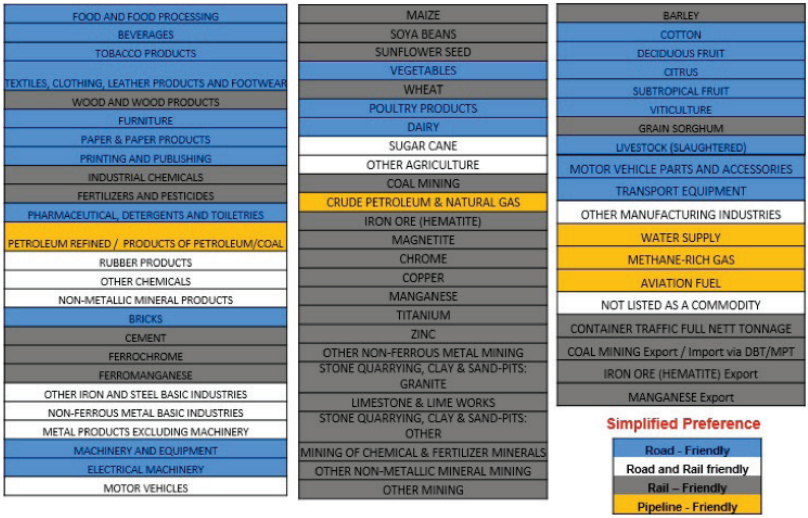


Figure 1: Commodities and their classification by road, competitive (road and rail friendly), rail and pipeline friendliness[2] (Source: Department of Transport, 2011)

[2] It should be noted that different organisations and entities define these categories differently, and these are not used as an absolute measure to determine modal shifting potential.

Figure 2 shows the relative proportions of the freight typology on South Africa's corridors. As is evident, break bulk is a large component of the corridor based movements, and there is therefore a large potential for movements of the freight from road to rail.

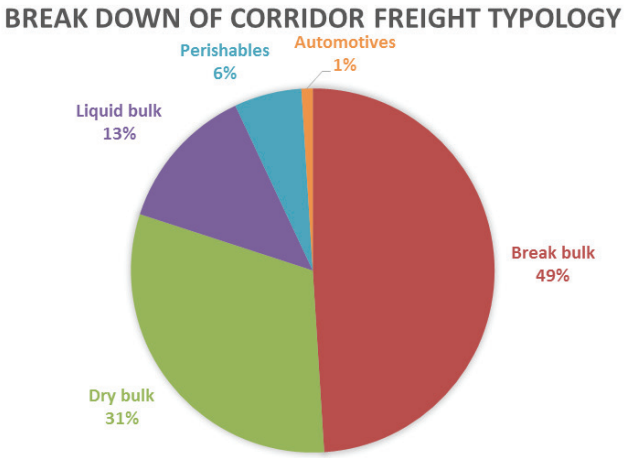


Figure 2: Total corridor freight break down by freight type

The results of an analysis completed by Havenga & Pienaar (2012) indicate an increasing trend in the mass of freight moved from 1993 to 2012, and a decrease in the rail market share of this freight. Havenga's study also revealed that currently, 41% of all freight (by mass) in South Africa originates and terminates in either Johannesburg, Cape Town or Durban. These corridor based movements have the greatest potential for the shift of road freight to rail as they are geographically bound corridor based movements, thus negating the negative effect of rail's lack of origin/destination flexibility.

The use of rail for the movement of freight means that there is often a need for inter-modal facilities on either end of the corridor based rail journey although there are exceptions where the freight originates at, or is destined for, a marine port. These inter-modal facilities are typically referred to as 'dryports'.

Dryports

Dryports are the term given to inland, inter-modal points which shift the rail from road to rail or vice versa. They have been used extensively in Europe, North America and Latin America (Konings, 2008). South Africa's intermodal points are the weakest points of our freight transport system (Beytell, 2012) and their improvement should thus be a priority (National Planning Commission 2012).

South Africa's most significant inter-modal point is City Deep in Johannesburg, the largest inland port in Africa and the fifth largest in the world. Yet, even though it is being underutilised, it is not large enough to handle the projected increase in freight if the shifting of freight to rail is to occur at the anticipated rate (Gauteng Growth and Development Agency, 2011).

In considering future priorities for rail freight, it is notable that 80% of break bulk could be serviced by only four inter-modal facilities in Gauteng, Durban, Cape Town and Port Elizabeth (Havenga, 2013).

2.2 Road infrastructure

Road infrastructure is affected by several factors, including: environmental factors, the absolute volume of vehicles on the roads and the weight of these vehicles. The road is designed to carry a certain number of Equivalent Standard Axles (ESAs) during its design life. An ESA is a theoretical measure used to convert all vehicle axles into the same unit of weight which can be used for design calculations more conveniently. The ESA is an 80kN load. The ESA for a vehicle is calculated as shown in the formula below:

$$1\ \text{ESA} = \left(\frac{\text{Vehicle single axle weight}}{80\ \text{KN}} \right)^4$$

Note that this is a simplification of the actual formula, as the formula has factors built in for rigid and flexible pavements. For the purposes of this study, the above formula is adequate as the roads being compared have similar rigidities.

Applying the above formula, it can be calculated that a typical passenger car axle (850kg or 8.5kN axle) does 0.002 times the damage that a typical 32t truck axle (4000kg or 40KN axle) does, or that the truck axle does nearly 500 times the structural damage that the car axle does.

The road will require a construction event such as the renewal or replacement of a road layer when it has reached the end of its design life. South African National Roads Agency Limited (SANRAL) generally builds roads which have a wearing course design life of approximately 20 years, accounting for projected increases in traffic volumes over the road's lifespan. As the design life is related to a specific number of equivalent standard axle passages, the removal of heavy freight vehicles from these roads should cause the design life of these roads to increase, thus reducing the capital and operating costs necessary for upkeep of these roads.

In addition to the impact of traffic load on the design life of a road, the environment (heat, rainfall etc.) also causes deterioration. Figure 3 illustrates the relative contribution of the traffic load and environment, the two main aspects which affect the road's degradation, and how they vary according to the number of ESAs the road is designed to carry. It shows that for low volume roads the environmental effects are the primary cause of degradation, with the traffic load being the main contributor for high volume roads. The roads that are the primary concern for this study, namely the SANRAL corridor roads, are designed to last longer than the 1 million ESAs that is the equivalence point in the graph, and therefore the traffic load should be the primary contributor to the road's degradation.

According to Louw Kannemeyer, SANRAL's Road Network Manager, SANRAL's use of the mechanistic empirical design methodology, which originates in the 1970's, has ensured that the roads are structurally very well designed and built. While the roads are designed primarily for traffic loading, he acknowledges that the environment is a driver of road degradation of SANRAL corridor roads. The design methodology used in South Africa has been very successful, which is highlighted in the fact that 76% of pavements of the 21 400 km of SANRAL roads are over their 20 year design life, yet only 8.5% are in a poor or very poor condition[3] (SANRAL 2013 and Louw Kannemeyer, personal communication).

[3] *The road is determined to have structurally failed if a rut depth of >20mm is recorded*

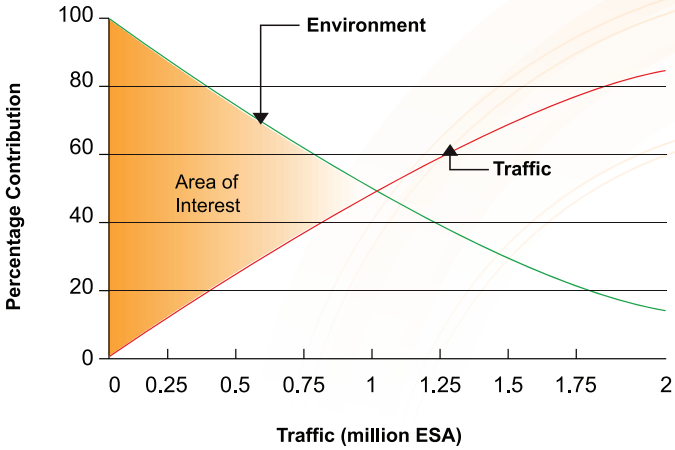


Figure 3: Traffic loading versus dominant mechanism of distress (SADC, 2003)

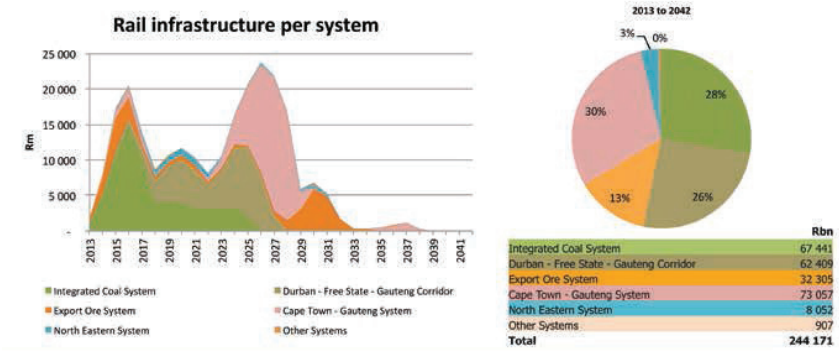
Due to the fact that there is a fourth power relationship between the damage that a vehicle axle does to a pavement, and its weight, it has been found that often the heaviest 20% of vehicles account for up to 80% of the damage that occurs to a pavements structure. This is a general rule of thumb though, as it depends on the total volume of lighter vehicles which travel on that road too. Numerous case studies on road infrastructure have found that the heaviest 20% of vehicles can account for anything from 2.5% of the damage on a road to 100%, which can occur if a single overladen vehicle destroys the entire pavement structure in one pass (US Department of Transport, 2013). This variance in effects show that it is very difficult to anticipate the resulting change in capital and operating expenditure required for roads due to the reduction in freight vehicles on these roads although, in principle, it remains obvious that the reduction in freight movements on roads will increase the road's service life. This increase in service life may lead to decreased, or more spread out, maintenance and rehabilitation events.

For the purpose of this analysis it is assumed that SANRAL's expenditure on roads will change slightly depending on the number of trucks on their roads. There is a factor in place which does reduce capital expenditure depending on the rate of uptake of freight by the railways. The factor is based on the US Department of Transport (2013) research, and applies a 20% reduction in operating and capital expenditure for the high freight uptake outlook, with lessor reduction depending on the freight uptake outlook being investigated.

2.3 Rail infrastructure

Transnet is the state owned company responsible for the maintenance and upkeep of rail infrastructure and vehicles in South Africa. Their mandate is to 'assist in lowering the cost of doing business in South Africa, enabling economic growth and ensuring security of supply through providing appropriate port, rail and pipeline infrastructure in a cost-effective and efficient manner' (Transnet, 2013).

Transnet's Long Term Planning Framework (LTPF) contains details about projected capital expenditure, by rail system, for the forthcoming 30 years, as can be seen in Figure 4.



- Large infrastructure expansion requirements on the Coal System in the next 5 years.
- Durban – Gauteng corridor requires substantial investment in the medium term 5-10 years.
- Over the medium to longer term (10-15 years) substantial capacity expansions are required on the Cape Town – Gauteng route.
- Land acquisition costs are not reflected.
- No provision is made for rail gauge changes on high speed passenger solutions.

Figure 4: Transnet (2013) projected expenditure on rail infrastructure

2.4 Modes of freight movement

2.4.1 Trucks

The Road Freight Association (RFA) publishes a vehicle cost schedule every year, which contains information pertaining to different codes of vehicles and their costs. This schedule is published in order to help RFA members determine the feasibility of rates before any costs are incurred. It contains information on both capital and operating costs of vehicles.

The codes of these vehicles are in approximate order of increasing payload and number of axles. The most common heavy motor vehicles used for corridor based freight transport in South Africa are RFA codes 09, 11 and 19 (this was determined in consultation with academic practitioners and the RFA).

In order to calculate the economic impact of road freight, calculations are made on the basis of ton-kilometres. Considering each truck type which will have a specific payload, this is calculated as follows:

Annual t.km capacity = (truck payload)(truck annual distance)*(mass utilisation)*(percentage of distance laden)*

To simplify analysis a single representative vehicle is used, as the usage and payload statistics of the stated codes are considered to be close in magnitude.

2.4.2 Trains

Trains, with much larger carrying capacity obviously have the ability to move greater quantities of freight. While rail systems have large capital costs they also have relatively low running costs per ton.km (when operating at full capacity) making them effective in reducing the costs of logistics under circumstances where the freight has a relatively low mass to value ratio.

Capital expenditure on rail vehicles

Rail vehicles consist of locomotives and wagons. Locomotives can be powered by electricity, diesel or a combination of the two[4]. Wagons are designed to suit the type of freight being transported. Transnet, as part of its capital investment programme is planning for large scale additions and rehabilitation to its rolling stock (vehicles), as illustrated in Figure 5.

[4] *Transnet anticipates the addition of compressed natural gas locomotives in the duration of this investigation (up to 2050) (Transnet, 2013).*

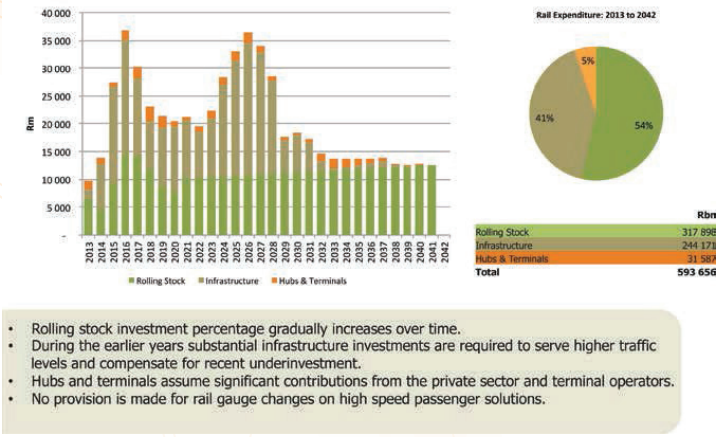


Figure 5: Transnet (2013) projection of capital expenditure on rail locomotives, infrastructure and hubs & terminals

Capital expenditure on infrastructure

Capital expenditure on infrastructure includes railway line expansion and rehabilitation, together with related signalling and control systems (see note below Figure 5 which indicates that rail gauge changes are not provided for).

Operating expenditure

Operating expenditure on rail infrastructure consists mainly of the following items (Profillidis, 2014):

- Maintenance and renewal of track (rail, sleepers and ballast) and subgrade
- Maintenance of electrification, signalling and telecommunications facilities and substations (where applicable)
- Maintenance of tunnels and bridges
- Maintenance of platforms (in stations)

The breakdown within this is approximately 65% for track and platforms, 30% for electrification, signalling telecommunications and substations, and 5% for bridges and tunnels.

2.5 Socio-economic modelling

The socio-economic impact of changing the structure of the transport sector, needs to be considered in four parts:

a) ***Direct impact*** which is associated with employment and net costs – capital and operating - of the road or rail system itself.

b) ***Indirect impact*** due to backward linkages which are caused through the changes in inputs to the road or rail system through, for example, the purchase of fuel and vehicles. This occurs as a result of re-expenditure of businesses/companies which have the expenditure of the direct industries as their inputs. These backward linkages impact on sectors of the economy separate from transport. These other sectors may be affected positively or negatively depending on the change in purchases from these sectors by the transport sector.

c) ***Induced impact*** due to direct and indirect expenditure occurs as a result of any incurred expenditure in the broader economy. This is generally reflected in increased household expenditure, as a result of an improvement in revenue due to one of the 'factors of production' including production and distribution. Induced impact also occurs as part of additional household consumption.

d) ***Surplus effect***: This includes the 'forward' impact which is caused by the change in the amount of transport used (and purchased from the transport sector) by all the sectors of the economy where freight movement is required. This impact is assessed through the change in price of transport (a lowering in price causes the sectors which use freight transport to be more effective and hence employ more people and have greater sales).

For the purpose of this analysis, the direct impacts are calculated from first principles based on changes in modal shift and hence changes in the cost of both road or rail systems and changes in the number of people working on these systems. In the case of the indirect impacts (backward and forward) economic models are required to assess both the change in economic impact, measured as Gross Domestic Product, and jobs.

This analysis relies on two different models to determine economic and job impacts of the shift in freight from road to rail: and 'Impacts' Model, which deals

[5] In this regard it is notable that Transnet anticipates that a modal shift can save the economy up to R1150bn in a reduction in externalities in the next 30 years compared to the business as usual uptake outlook

with backward impacts, and a 'Surplus' Model which deals with forward impacts. These models, created by Conningarth Economists, are input-output models, which utilise a Social Accounting Matrix (SAM) to relate net costs incurred in one area of the economy to other sectors of the economy.

The Impacts Model is the model which takes into account any direct expenditure, both construction (capital) expenditure and operating expenditure. This model will provide the direct, indirect and induced effects of this expenditure, in full time equivalent jobs, broken down into skilled, semi-skilled and unskilled jobs, as well as impact on the GDP. It is important to note at this point that these effects are geographically confined to the area of investigation, thus any expenditure which leaves the area of investigation (such as money which is used to import goods) is money which does not contribute to South Africa's GDP.

The second model is the Surplus Model. This model's inputs are the expected surplus effects that any expenditure will have on the economy. This is not an output of the Impacts Model.

Considering the Impacts Model, it requires two input costs: construction (capital costs) and operating costs. The construction (capital) costs are the investments in the road and rail infrastructure and vehicles, and the operational costs are the costs of operating the vehicles for both road and rail, as well as the operating costs of the road and rail infrastructure. The most significant part of the operating costs is the cost of maintaining the vehicles.

There are different types of effects that spending can have on the economy. This requires an understanding of the sectors which are linked to the transport sector. As noted above, backward linkages are links which are upstream to the sector being investigated, and would generally supply input (such as material or information) to this sector. For freight movements, the backward linkages include fuel, suppliers and servicers of vehicles and infrastructure, as well as any other service providers (administrative support, IT support, human resources support etc.) which may contribute to the running of a freight system.

The forward linked impacts of freight transport are significantly larger, as the movement of freight has repercussions throughout the economy, due to the fact that the movement of products is often part of the products life cycle (very few products have their entire life cycle from creation to consumption in the same geographical region).

Externalities

In order to simplify this analysis externalities are not specifically included in the modelling but comment is included on the extent to which this impacts on recommendations is raised below. Typically these include the impact of accidents, congestion, emissions, landway (land acquisition costs), noise and policing. They are costs which are arise as a result of operations or economic activity which occurs outside of the financial boundary of the organisation. They are a burden or "tax" on the broader environment or society (Transnet, 2013).

As an indication of the cost to society of these externalities, figures from Transnet are given in Table 1 (Transnet, 2013).

Table 1: Cost of externalities (Transnet, 2013)

	SA road (c/t.km)	SA rail (c/t.km)
Accidents	4.9	0.4
Congestion	1.9	0
Emissions	4.6	0.8
Landway	1.0	0.1
Noise	1.9	0.02
Policing	0.3	0

One additional externality is the cost to the economy when there is an electricity shortage and rail is no longer able to function. Rail uses approximately 1.5% of South Africa's electricity so this may become a more important factor in the next 5 years as supply is likely to be low over this period.

2.5.1 Job impacts

A large component on the socio-economic modelling process is the impact that the different types of expenditure will have on the job market. For the purposes of this study, a labour-year needs to be defined: one labour-year is the amount of work which one person performs assuming he or she is working for a full year.

The output of the model is given in total labour years, by both sector and labour skill type (skilled, semi-skilled and unskilled). The model also has the ability to produce results for ethnic group and gender, although this uses empirical data which is not necessarily accurate in the long term, so these results are excluded.

2.6 South Africa's freight sector

Statistics are kept on a wide range of different commodities being moved throughout the country with 74 codes of goods. These commodities can be grouped according to the way they are moved, either by road or rail, or by the type of movement, namely: corridor based, rural or metropolitan (see Table 6 for more detail).

Table 2: Summary of freight types and modal split

Movement type	Percentage of national transport effort	Percentage rail for movement type
Total	100.0%	12.5%
Corridor	64.7%	19.3%
Metro	2.9%	4.6%
Rural	32.4%	15.3%

Considering commodities moved by rail, according to the Group Strategy Division of Transnet, the respective make-up of bulk and general freight commodities varies according to the railway line that they are moving along, making the quantification of those commodities which are likely to shift modes very complex. A simplifying assumption for the purposes of the calculations used in this study is that only export coal from Mpumalanga, iron ore from Sishen and Manganese from Hotazel which moves via rail are bulk commodities. The remaining codes are classified as general freight (Transnet, 2013). However, while the majority of bulk freight is moved by rail currently, this is not universal and particular attention is paid in a later section to bulk commodities which are currently moving by road. This includes coal for power stations in Mpumalanga (43 million tons p.a. via road), sugar cane in rural Kwa-Zulu Natal (12.3 million tons p.a. via road) and stone in rural North West (6.6 million tons p.a. via road).

Projections indicate that in the next 30 years, processed food and chemicals will amount to 44% of break bulk freight (which constitutes 49% of total freight) on the two largest corridors, Gauteng to Durban and Gauteng to Cape Town. Due to the large percentage of the total movements coming from only two commodities, it is easier for the authorities or relevant service providers to identify the large generators of this freight, and thus engage directly with them in order to facilitate the modal shift from road to rail. For example, palletised cargo (such

as pallets of canned food or cement bags) is better suited for movement via rail than un-palletised goods, such as crated soft drink or stacked cement bags, as it is easier to load and unload from the train wagons.

Currently, break bulk products make up 49% of the freight movements along all corridors, and approximately 45% of this is already palletised. The absolute volume of break bulk is set to more than triple in the next 30 years. International trends indicate that 80% of break bulk cargo moves in containers which are easily transferable to rail. The propensity to use containers is set to increase, which will lead to a faster growth in traffic which could make use of intermodal facilities (Global Security 2013).

Importance of inter-modal transfer facilities

The National Planning Commission (NPC) states in the National Development Plan (NDP) that intermodal points are currently not in an adequate condition, and this is one of the key reasons why freight is not making the move back to rail from road. The primary corridor which needs to be focussed on first is the busiest corridor in the country, namely the Gauteng-Durban corridor (National Planning Commission, 2012).

Conclusion on technical considerations relating to modal shift

These statistics indicate that South Africa's freight make up is one which is conducive to making the shift from road to rail though, according to the NPC, our intermodal facilities are not yet at the standard which would facilitate this change and, therefore, need to be prioritised as part of the road to rail interventions (National Planning Commission, 2012).

3 Methodology

There are three main components which are important when considering the socio-economic impact of the shift of freight from road to rail. These components are:

- The quantification of freight movements and the proportion of this which could make the shift from road to rail,
- The overall costs of moving freight, including the construction and capital costs, as well as the operational costs,
- The socio-economic modelling and the resulting effects on the GDP and employment

It is important that the methodology which underlies the freight demand model, costing approach and socio-economic model is explicitly stated in order to ensure the accuracy of the results.

3.1 Freight demand model methodology

For the purposes of this study, the following assumptions and simplifications have been made:

- The different directions on the corridors are aggregated into one total corridor movement.
- Only the movements via rail of export coal, iron ore and manganese are excluded from the study as they are already on rail and the volumes are significantly larger than the general freight movements, thus distorting results.
- The mix of commodities remains constant over the period of the study (up to 2050), and therefore movement of each commodity increases at the same rate.

3.2 Costing methodology

The costs which are calculated are not allocated specifically between the different actors in the sector, namely the private and public sector. This project is looking at the overall impact of the expenditure in the economy, the source of the money is not important, as the effects of the expenditure (from a job and GDP impact perspective) are the same.

There are two types of costs which serve as the primary inputs into the macroeconomic model, namely the construction (capital) costs and the operating costs.

The costs were sourced from a variety of sources, as Table 3 shows.

Table 3: Data resources for costing model

Aspect of costing model	Road	Rail
Vehicle capital cost	Road Freight Association tables	Transnet Long Term Planning Framework

Aspect of costing model	Road	Rail
Infrastructure capital cost	South African National Roads Agency Limited Asset Management Plan, bilateral discussions & own calculations	Transnet Long Term Planning Framework
Vehicle operating cost	Road Freight Association tables	Transport Research Support, Public-Private Infrastructure Advisory Facility, World Bank (2011)
Infrastructure operating cost	SANRAL Asset Management Plan	Transport Research Support, Public-Private Infrastructure Advisory Facility, World Bank (2011)

Each of the aspects of the costing model are described below.

Capital expenditure on road infrastructure

For the purposes of this study, the SANRAL capital expenditure on roads has been projected up to the year 2050 based on previous expenditure and the 3 year projections which have been provided in the asset management plan (SANRAL, 2013). The planned expenditure per year is R5.7bn.

Operating expenditure on road infrastructure

SANRAL provides operating expenditure details for the following three years as part of their asset management plan (SANRAL, 2013). The planned expenditure per year is R1.73bn.

Capital expenditure on road vehicles

Three different types of freight vehicles are most common on South African roads. The vehicles are given numbers in the approximate order of increasing payload. South Africa's most common vehicles have RFA codes 09, 11 and 19. It is assumed in the model that there is a 33.3% market share of the vehicles on the road. The costs are as follows (VAT incl.) (RFA, 2014):

- 09 – R 1.5 million
- 11 – R 1.6 million
- 19 – R 2.1 million

The new demand generated as a result of growth in the general freight sector is matched with the purchase of new vehicles, in the ratios mentioned above. In addition to this the vehicle is depreciated over a period of time (from the RFA tables), after which a new vehicle will need to be purchased as a capital expense. The salvage cost is assumed to fund a portion (25%) of the new vehicle.

The rate of purchase of vehicles is constantly increasing, as there is constant growth within the road freight sector overall. For the years 2034 to 2043, there is no need for any new vehicles on several corridors[5], as the rate of growth of rail is reducing the volume of freight which road vehicles are moving. During this period there is negative growth within the road freight industry on several corridors. This does not affect the overall road freight movements, as it is still increasing.

Operating expenditure on road vehicles

The RFA vehicle cost schedule has information on the operating expenses incurred per vehicle type per t.km. The costs (excluding depreciation) are as follows (RFA, 2014):

- 09 – R1.24/t.km
- 11 – R1.10/t.km
- 19 – R1.11/t.km

In the model these are broken down into fuel, staffing, maintenance and other costs. Each vehicle type has its own breakdown of these costs, for instance the breakdown for the code 09 vehicle is 35% fuel, 22% maintenance, 19% staffing, 7% depreciation and 17% other (such as licensing, insurance etc.).

This component of the entire costing model is significantly larger than the other components. It is increasing every year as the absolute transport effort is constantly increasing, beginning at R176bn.

Capital expenditure on rail infrastructure

The export lines are not assumed to contribute to the capital expenditure due to freight modal shift (approximately R100bn of total expenditure relates to these

[6] *Although replacement of vehicles which have reached the end of their useful lives needs to continue.*

lines), therefore the total capital expenditure on rail infrastructure is approximately R144bn according to Transnet LTPF (2013). (See Figure 6 for more information).

Included in the capital costing model is a provision for a new railway line through Mpumalanga which will alleviate the pressure that the trucks are currently placing on the road infrastructure there. This railway is not included in the Transnet LTPF plans. The proposed expenditure would include a branch which leads to the new power stations, namely Kusile and Medupi. A high level estimate of the capital cost is made, at R50bn[6]. If this is added to the Transnet figure for general freight lines of R147bn, the projected total capital expenditure is R194bn up to and including 2050.

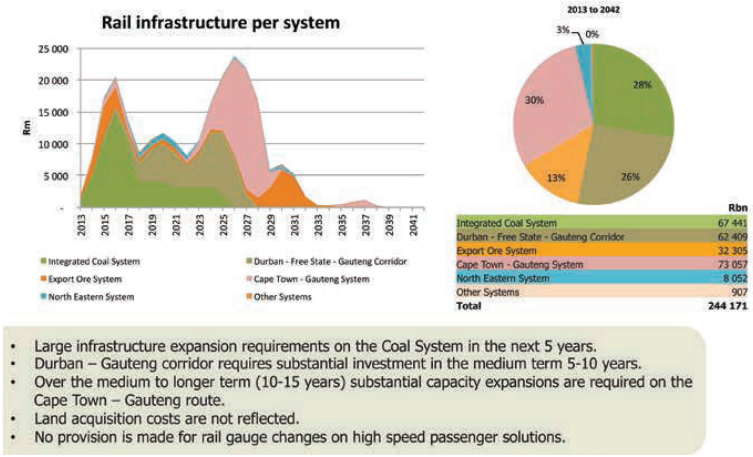


Figure 6: Transnet (2013) projected expenditure on rail infrastructure

The movement of stone in rural North West and sugar cane in rural Kwa-Zulu Natal are areas of particular concern (as mentioned in Section 2.6) with regard to rural movements. The negative effect of the trucks on the roads in these areas is significant, and measures need to be taken in order to negate these effects. However, the extent to which rail can provide a solution remains uncertain and is not included as part of this study[7].

[7] This estimate is derived from previous expenditure figures on new rail infrastructure, with estimated length of approximately 300km in total.

Operating expenditure on rail infrastructure

Due to the unavailability of information specifically for the operating expenditure on rail infrastructure, figures from the Transnet Audited Financial Statements were used to calculate total operating expenditure, which includes components for both the rail infrastructure and vehicles. The cost is included below, together with vehicle operating cost.

Capital expenditure on rail vehicles

The freight demand model includes a 'density' component which converts the mass of the commodity moved into an equivalent Twenty foot Equivalent Unit (TEU) which is the unit moved by trucks and trains. It is estimated that each train can move 300 TEUs per trip. This figure is used to calculate the requirement for new rail vehicles. In addition, the costs of new vehicles to replace vehicles which reach the end of their useful lives is included in these calculations.

The calculated expenditure to 2050 is R422bn, which correlates with the anticipated Transnet expenditure of R317bn to the year 2043.

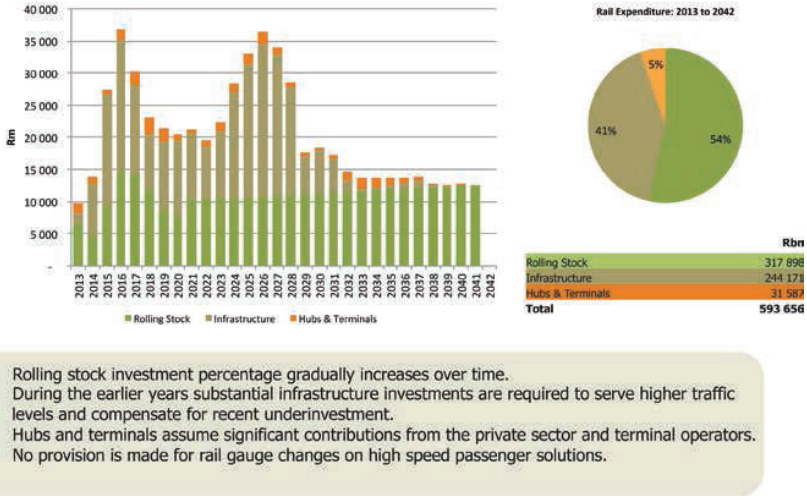


Figure 7: Transnet (2013) projected capital expenditure on rail vehicles

[8] *An optimisation exercise in the layout of the track may yield a result which is better for both the producers and the local authorities in the area who manage the roads, but considerable uncertainty remains regarding the feasibility of a rail solution,*

Operating expenditure on rail vehicles

The Transport Research Support, Public-Private Infrastructure Advisory Facility (PPIAF) and the World Bank created a toolkit which was aimed at advising railway operators and policy decision makers in methods and practices which may aid in increasing the sector's performance. A component of this was to investigate the costs of the different modes. It was found that in Europe, the costs of moving general freight was between US$0.04 and US$0.06 per t.km (R0.44 to R0.66 per ton.km). It was found to be slightly cheaper in the USA for bulk freight at US$0.03 (R0.33 per ton.km). This correlates well with the figures that come out of the Transnet Audited Financial Statements (see below). Transnet is on the high side of the international standards, as the figures from the Financial Statements included operating expenditure on the rail infrastructure.

Due to the unavailability of information specifically for the operating expenditure on rail vehicles, figures from the Transnet Audited Financial Statements were used to calculate total operating expenditure, which includes components for both the rail infrastructure and vehicles. This value is R0.66 per t.km. This includes direct operating costs such as staffing costs, energy costs, maintenance and any other expense associated with the movement of freight and upkeep of rail infrastructure, but excludes depreciation as this is considered separately in the economic modelling (Transport Research Support, 2010).

Dryports

The design of a dryport is outside of the scope of this investigation, although the socio-economic impacts of their construction and operation are important contributors to economic growth and employment. Without an efficient intermodal arrangement the road freight will not shift to rail.

It is estimated that the construction costs of these dryports will be R500m each. This figure is extrapolated from the construction costs of existing dryports constructed in the country, such as City Deep and Tambo Springs.

Cost projections

Economic projections are discussed later in this report, recognising that they are driven by the costs of transport. It is notable that the analysis does not attempt to project different costs at different growth rates.

3.2.1 Cost summary

The costing methodology yielded the results in Table 4 for the period 2014 up to and including 2050 for the Transnet (High) uptake freight outlook (see following sections for explanation of uptake rates).

Table 4: Total costs up to and including 2050 (R billion at constant 2014 prices)

	Road	Rail
Vehicle capital cost	921	91
Infrastructure capital cost	263	144
Vehicle operating cost	15 191	1 714
Infrastructure operating cost	83	

Table 5 states these values on an annual basis, taking the average annual costs over the period from 2014 to 2050 into consideration. It is interesting to note that the operating cost of the road vehicles is dominant.

Table 5: Costs incurred per year (2014 Rbn)

	Road	Rail
Vehicle capital cost	25	2.0
Infrastructure capital cost	7.0	4.0
Vehicle operating cost	422	47
Infrastructure operating cost	2.0	

The costs which are provided can be added together, as these figures are in real terms and are, therefore, not discounted.

As with the figures in Table 4, those in Table 5 are not discounted. Figures are calculated as real expenditure (net of inflation). As this is an average of total expenditure the figures assume growth on a linear basis, and these figures then represent the approximate expenditure in the year 2032.

3.3 Socio-economic modelling methodology

For the ***Impact Model*** the inputs are the total capital (what the models refer to as 'construction') and total operating costs. These are used to calculate the total impact on GDP and job formation in the South African economy over the analysis period from 2014 to 2050. (The outputs which are presented in Table 4 are the inputs to the Impacts Model). These results will vary by the freight outlook assumed for each run, as the relative proportions or road and rail change with each outlook.

The outputs of the model are the total direct and indirect impact on the GDP of the country's main economic sectors and the job impact (broken down into skilled, semi-skilled and unskilled components) for the full analysis period. These can be averaged to get an annual impact. The job impact is calculated by using job intensity factors, which attribute a certain number of jobs for the expenditure incurred in each sector. For instance, a large portion of the expenditure in agriculture would be attributed to the wages of the employees, thus it would have a higher expenditure, rather than in an industry such as manufacturing, where the component which is attributable to wages would be less as there are higher raw material costs.

In the case of the ***Surplus Model*** the model requires a change to be tested (what is the impact on the economy of changing the amount of surplus available). The model requires combined capital and operating costs which would typically be calculated as a net present value. However in this case as the capital and operating costs are both a stream of 'real' costs they are simply added. Results represent the difference between the 'business as usual' outlook and the outlooks with higher proportions of freight on rail.

4 Analysis

4.1 South Africa's current freight movements

According to the freight demand model, there are 643 million tons of freight moving through South Africa annually. 87.5% of this is moving via road, and the remainder via rail. Further breakdowns are provided in Table 6.

Table 6: Summary of freight movements by tons in South Africa

Movement type	Road (Mtons)	Rail (Mtons)	Percentage rail market share
Total	**563.1**	**80.3**	**12.4%**
Corridor	184.0	35.5	16.2%
Metro	124.1	5.8	4.5%
Rural	255.0	39.0	13.3%

Due to the confined nature of railways, they are most effective when freight movements have a similar nature. Rail is therefore most applicable for corridor based freight movements. Dispersed rural movements, with scattered OD points are not suited to rail as the construction of the infrastructure for this is too expensive. This study has chosen the five largest corridors in the country as the main focus for the movement of freight from road to rail, as these have the largest shifting potential due to the constant flow of commodities and the set origin and destination points. The other corridors freight movements are also considered for modal shifts, although they have been counted as one entry for ease of calculation.

These corridors, as well as the complete general freight balance for South Africa, are shown in Table 7. The volumes shown in Table 7 are for both directions (i.e. the total flows in both directions on that corridor).

Table 7: Summary of general freight movements by tons in South Africa (2012)

Corridor	Road (Mtons)	Rail (Mtons)	Percentage rail
Gauteng – Durban	46.8	6.4	12.1%
Gauteng – Cape Town	34.2	1.7	4.7%
Durban – Cape Town	9.0	<0.1	0.0%
Durban – East London	8.8	<0.1	0.0%
Gauteng – Port Elizabeth	5.7	0.3	5.0%
Other corridors	79.4	27.1	25.4%
Metro	124.1	5.8	4.4%
Rural	255.0	39.0	13.3%
Total	**563.1**	**80.3**	**12.5%**

Table 8 shows the country's national freight balance by transport effort, measured in ton.kilometre.

Table 8: Summary of general freight movements by ton.kilometre in South Africa (2012)

Corridor	Road (Mtons)	Rail (Mtons)	Percentage rail
Gauteng – Durban	19.5	3.4	15.0%
Gauteng – Cape Town	27.7	0.9	3.2%
Durban – Cape Town	11.0	<0.1	0.1%
Durban – East London	4.2	<0.1	0.0%
Gauteng – Port Elizabeth	4.4	0.2	4.0%
Other corridors	34.6	12.7	26.8%
Metro	4.8	0.5	9.3%
Rural	46.9	12.6	21.2%
Total	**153.3**	**30.3**	**16.5%**

The study corridors are represented geographically in Figure 8.

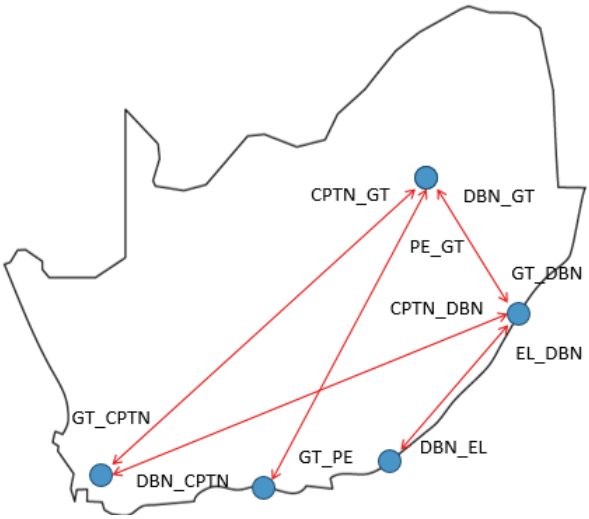


Figure 8: Diagrammatic representation of the study corridors

4.2 Freight movement projections

As this study is looking as the potential movements from road to rail, it requires a long time frame to be investigated in order for this to happen. One of the largest drivers of freight growth is the real rate of growth of the country's economy.

There is broad consensus that there is a strong link between the growth rate of the country's GDP and the rate of growth of freight movements (Feige, 2007; Verny, 2007; Bureau of Transportation Statistics, 2014), although it has been shown that there is not a direct correlation between the two, and there are underlying mechanisms that should be interrogated before the link is made between the two. For instance, the rate of growth is usually measured in t.km, so it may be the spatial dispersion which is occurring, rather than the growth of the freight itself. For the purposes of this study, it was assumed that the rate of growth of general freight is equal to the projections of economic growth. Transnet anticipates a growth rate of general freight of 4.5% per annum, which is the figure used for 2020 onwards. The economic growth projections used in this analysis are taken from the best available current data and are shown in Table 9.

Table 9: Economic growth projections (StatsSA and IDC, 2014)

	2015	2016	2017	2018	2019	2020 to 2050
Economic growth	3.20%	3.50%	3.90%	4.00%	4.00%	4.50%
Freight movement projected increase	2.95%	3.25%	3.65%	3.75%	3.75%	4.25%

For the purposes of this analysis, total freight movements are assumed to increase at the rate of economic growth given in this table. The Freight Demand Model uses a 'Likely-GDP' increase of 3.89% per annum and a 'High-GDP' increase of 4.6% per annum, so the projections made in this model and between these two categories (Transnet, 2013).

4.2.1 Selecting different freight outlooks for analysis

Four 'outlooks' were modelled in order to anticipate the potential socio-economic impacts of the modal shift. The first one is referred to as 'business as usual' where there will be no modal shift on freight corridors. To get an outer limit regarding the modal split, Transnet's 'aspirational' goal of having a 70% market share of general freight in corridor movements throughout the country by the year 2043 is assumed. It is important to note that the definition of general freight

in this context is all non-bulk freight which is movable by rail, as well as by either road or rail.

This modal split of 70% by 2043 and is modelled as the 'High uptake' outlook. Two intermediate outlooks are assumed, to give medium and low uptake outlooks for the modelling, as described below.

The uptake rate of freight by rail is the single variable which is altered when changing freight uptake outlook. The capital investment in infrastructure is relatively constant, as it has been assumed that the Transnet investments in infrastructure will continue, regardless of the rate of uptake that the freight follows. This is because the capital investment is the lead event in the modal shifting process, as freight cannot shift onto rail infrastructure that does not exist. The road capital investment will also not be significantly different, as mentioned previously, due to the reduction in freight traffic loads not having a significant effect on road capital expenditure.

The projections are made as follows:

- Business as usual uptake outlook:
  - Market share of rail is maintained at 14.5% of corridor freight
  - Metropolitan rail market share is maintained at 9.3%
  - The rural market share is maintained at 21.2%
  - The surplus effects are zero, as there is no change from road to rail
  - There will no coal line constructed in Mpumalanga.
  - There will be no dryports constructed.
- High (Transnet projected) uptake outlook:
  - 70% market share of corridor freight by 2043, 70% constant share thereafter.
  - Metropolitan rail market share increasing by 0.2% per annum (this number comes from empirical evidence concerning the applicableness of rail in urban areas).
  - The rural market share increases by 0.2% per annum (this number comes from empirical evidence concerning the applicableness of rail in rural areas).
  - There will be a coal line constructed in Mpumalanga.
  - There will be 5 dryports constructed.
- Medium uptake outlook:
  - 50% market share of corridor freight by 2043, 50% constant share thereafter.

- Metropolitan rail market share increasing by 0.1%.
- The rural market share increases by 0.1% per annum.
- There will be no coal line constructed in Mpumalanga.
- There will be 5 dryports constructed.

• Low uptake outlook:
- 30% market share of corridor freight by 2043, 30% constant share thereafter.
- Metropolitan rail market share increasing by 0.05% per annum.
- The rural market share increases by 0.05% per annum.
- There will be no coal line constructed in Mpumalanga.
- There will be 5 dryports constructed.

4.2.2 Freight projection results

Using the 'High uptake' outlook the rail market share is shown in Figure 9 below. The noticeable kink in the year 2042 is due to the corridor based movements achieving the 70% modal share, and maintaining this while the total volume of freight moved is increasing.

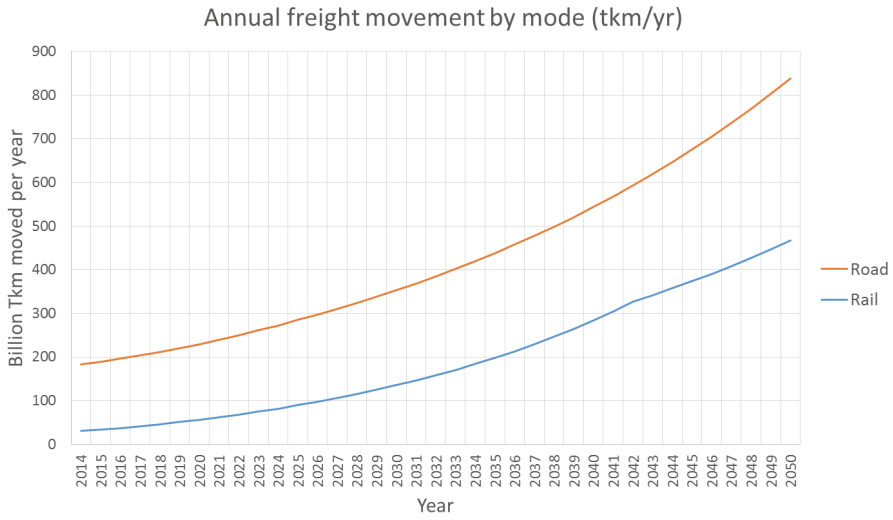


Figure 9: General freight movement by mode (including corridor, metropolitan and rural movements) (Source: Author's model)

Figure 10 below shows the balance of movement types in South Africa by the nature of their movement. It is evident from this that the majority of general freight transport effort (in tkm) relates to corridor based movements.

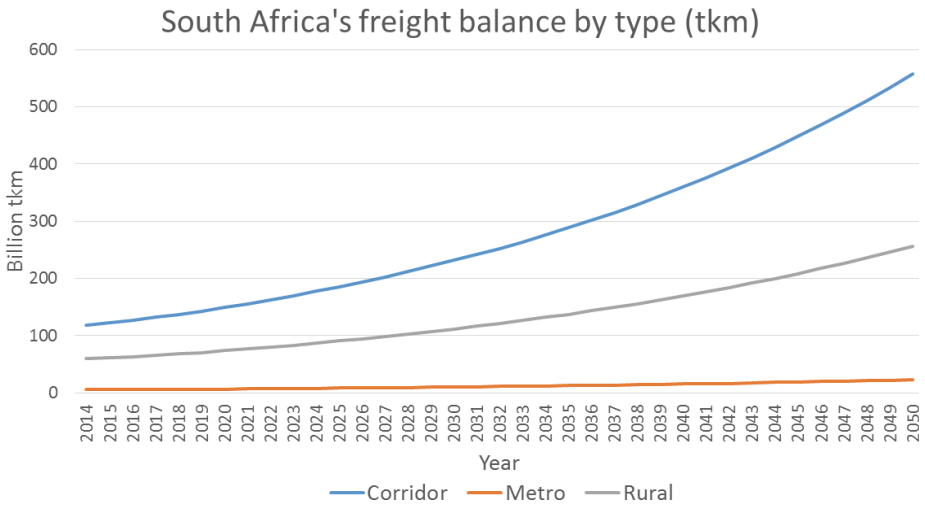


Figure 10: Breakdown of South Africa's general freight movement by type

The largest potential for the movement of freight from road to rail is in the corridor based movements, and this will have the greatest mitigating effect associated with a move from road freight transport, such as greenhouse gas emissions, safety issues as well as logistics costs.

4.3 Dryports

Five dryports will be needed in the country, as the origin of several corridors occur at the same point. The usage of the same port will increase the cost efficiency of these systems.

The total employment at dryports is calculated to be 20 000 full time equivalent jobs per year. This figure includes the drivers and assistants who will be working in the port itself, as well as the delivery drivers who will travel from the dryport itself to the destination in the city itself. This is calculated by estimating the distance from the dryport to a random location in the city, estimating curvature factors for circuitous roads in the city, speeds and loading/unloading time for the vehicles.

These estimations are made on a two shift, 16 hour day. This figure is the total figure for all 5 dryports, and varies according to the volume of freight which will enter and exit these dryports. It is assumed that rail connections, sidings etc. are included in the costs presented for these dryports.

The 20 000 dryport employees are employed in order to take the freight from the intermodal point to the final destination of that freight. These may be private sector logistics firms, or employees of the dryport itself. This may potentially increase the handling costs of the freight, although in the modelling this is assumed to be included as part of the costs for transporting the good from the dryport to the final destination.

5 Results

Macro-economic models can only model the major sectors of the economy, with 'transport' being one, covering the transport industry as a whole, thus including both the passenger and the freight industries. However, the economic interventions modelled are only for the freight component (excluding passenger transport). Further they relate primarily to 'general' freight moved along corridors. Therefore the results require interpretation to understand the impact within the transport sector. This is done in Section 5.5 below.

The business as usual outlook is run first as it serves as a base with which the other outlooks are compared.

5.1 Business as usual outlook

5.1.1 Effect on GDP

The combined impact of the construction and operational phase of the business as usual outlook will be the base from which the other outlooks are measured. The figure provided are the total contribution to the GDP up to and including the year 2050.

Table 10: Business as usual outlook effect on the country's GDP

Direct impact	Indirect impact	Induced impact	Surplus impact	Total impact
R 7 400 bn	R 6 300 bn	R 9 000 bn	R0	R 22 700 bn

5.1.2 Effect on economic sectors

The ***direct impact*** of the business as usual outlook are primarily in the sector of the economy which the expenditure occurs, namely the transport sector, although the building and construction industry also has a direct benefit. ***Indirect impacts*** are spread widely throughout the economy, with the chemicals (primarily fuel), manufacturing of transport equipment, electricity, trade, finance and insurance, business services and government services (part of community, social and personal services) sectors all benefiting from indirect expenditure.

The induced expenditure is further spread out through the economy, with the agricultural, beverage and tobacco industry, chemical and plastics, trade, electricity, transport, finance and insurance, business services and community, social and personal services sectors all benefiting from the expenditure in the economy resulting from the expenditure by households of their earnings from transport sector direct and indirect economic activity.

5.1.3 Effect on jobs

The business as usual outlook will create 124 million labour-years (approximately 3.4 million jobs per year) of employment over the period of this study. The breakdown of labour-year type is provided in Table 11.

Table 11: Business as usual outlook effect on the country's employment

	Direct impact	Indirect impact	Induced impact	Surplus impact	Total impact
Total jobs (million labour years)	27.9	37.5	53.2	**0**	123.6
Skilled jobs (% total)	20.3%	25.0%	27.3%	0	24.9%
Semi-skilled jobs (% total)	66.0%	54.7%	51.6%	0	55.8%
Unskilled jobs (% total)	13.7%	20.3%	21.1%	0	19.3%

The impact on jobs in specific sectors is the same as for GDP. This includes direct, indirect and induced impacts with the latter two distributing benefits through

most sectors of the economy. In the case of direct employment impacts this is dealt with in Section 5.5.

5.1.4 Surplus effects

Due to this being the base outlook, it is assumed that there are no surplus effects. Any improvement to the freight modal composition will have a surplus effect associated with it which is reported for the outlooks which include modal shifts.

5.2 Transnet (high) uptake outlook

This includes the Mpumalanga coal line, even though this line is not expected to be constructed in the Transnet LTPF, as well as the construction of 5 dryports.

The Transnet LTPF states that this outlook is the most likely level which the freight modal transition will attain.

It should be noted that due to a lower reliance on road vehicles and infrastructure, there is less expenditure which occurs on both the capital and operating sides. This in turn means that there is a smaller impact on both the GDP, and the employment which results from this.

5.2.1 Effect on GDP

The GDP is very responsive to the amount of expenditure which occurs in the country, hence the total increase to the GDP is lower.

The combined impact of the construction and operational phase of the Transnet (high) uptake are shown in Table 12.

Table 12: Transnet (high) uptake outlook effect on the country's GDP

Direct impact	Indirect impact	Induced impact	Surplus impact	Total impact
R 6 300 bn	R 5 500 bn	R 7 700 bn	R 3 600 bn	R 23 100 bn

5.2.2 Effect on economic sectors

The relative impact on the economy, in terms of GDP, in relation to the business as usual outlook is positive, primarily due to the surplus impact caused by a lowering of the cost of freight transport which benefits the economy as a whole. This is discussed further later in this report.

In terms of the sectors which are affected by the shift to rail, the sector make-up remains the same as for the business as usual outlook. But there will be less economic activity in the transport sector itself and the backward linked sectors, specifically chemicals (fuel), transport equipment manufacture, electricity, trade, finance and insurance, business services and government services[8]. However, as noted above this is more than offset by increased activity in the economy as a whole due to the surplus effect.

5.2.3 Effect on jobs

The high uptake outlook will create a total of 133 million labour-years over the period of this study, which is 7.5% more than the business as usual outlook. However, looking only at direct jobs in the freight transport sub-sector, taking an average for the analysis period of 2014 to 2050, this gives the direct job losses due to the freight modal shift amount to an estimated 116 000 jobs per year in the road freight industry (assuming a linear trend this is indicative of jobs in in the year 2032). A portion of this is offset by the estimated 20 000 jobs created annually from the initial construction and subsequent operation of dryports and the associated delivery of goods from the dryports, leaving the direct job losses in the region of 95 000, with 2032 representing the 'indicative' year. These figures are placed in relative terms later in this report.

Table 13: Transnet (high) uptake outlook effect on the country's employment

Million labour years	Direct impact	Indirect impact	Induced impact	Surplus impact	Total impact
Total jobs	25	34	48	27	133

The skills profile will be the same as for the business as usual outlook and the impact on sectors of the economy will be the same as for the GDP analysis.

5.2.4 Surplus effects

The surplus effects of this outlook refers to the total benefit to the economy when a more efficient transport solution is utilised. This opportunity cost is distributed through the economy and has its own set of direct, indirect and induced effects. The cost saving for the Transnet uptake outlook is R2 700 bn, and once the multiplier of 1.33X is applied, it results in a total increase to the economy of R 3 300 bn.

8 *Note that Transnet activity is categorised as a government service*

The impact on jobs of the surplus effect is discussed later in this report

5.3 Medium uptake outlook

This does not include the Mpumalanga coal line, yet it does include the construction of 5 dryports.

This outlook is a middle ground between the Transnet (high) uptake outlook and the low uptake outlook. It is designed to show that if some of the measures are taken, but not all, what the possible implications of this could be.

5.3.1 Effect on GDP

As in the high uptake outlook, there is a reduction in total expenditure, thus a reduction in GDP. The reduction is not as substantial, as expected with the rate and ultimate level of freight uptake is lower than in the high uptake outlook.

The combined impact of the construction and operational phase of the Transnet (high) uptake are shown in Table 14.

Table 14: Medium uptake outlook effect on the country's GDP

Direct impact	Indirect impact	Induced impact	Surplus impact	Total impact
R 6 700 bn	R 5 800 bn	R 8 100 bn	R 2 300 bn	R 22 800 bn

The pattern in terms of relative impact on sectors remains as for the other outlooks.

5.3.2 Effect on jobs

The medium uptake outlook will result in 130 million labour years of employment jobs over the period of this study. This includes the 700 000 labour-years created as a result of the construction and operation of 5 dryports. This is 5% more than the business as usual outlook. Looking at average annual figures there are direct job losses in the transport sector of 75 000 which can be seen as relating to the year 2032. But these are offset by jobs created in the economy as a whole as discussed later in this report.

Table 15: Medium uptake outlook effect on the country's employment

Million labour years	Direct impact	Indirect impact	Induced impact	Surplus impact	Total impact
Total jobs	26	36	50	17	130

5.4 Low uptake outlook

This does not include the Mpumalanga coal line, yet does include the construction of 5 dryports.

This outlook provides for only a modest uptake of rail transport along corridors in the country. But note that provision is included for the same number (5) dryports to be constructed. It is notable that in relation to the level of uptake of rail, in this outlook, there is a relatively high level of capital expenditure on rail infrastructure in proportion to the freight carried while the expenditure on road infrastructure is not substantially increased.

5.4.1 Effect on GDP

Even at this level of uptake there is a positive impact on the GDP for this outlook in relation to the business as usual outlook. Direct expenditure in the transport sector is still less, although the GDP does benefit by the creation of rail infrastructure as well as the high operating expenditure on road vehicles.

The combined impact of the construction and operational phase of the low rail uptake outlook are shown in Table 16.

Table 16: Low uptake outlook effect on the country's GDP

Direct impact	Indirect impact	Induced impact	Surplus impact	Total impact
R 7 100 bn	R 6 100 bn	R 8 600 bn	R 1 000 bn	R 22 900 bn

Relative impact on individual economic sectors remains as for the other outlooks. The relative impact in relation to these other outlooks is discussed below.

5.4.2 Effect on jobs

The low uptake outlook will result in 127 million labour-years over the period of this study. This includes the 722 00 labour-years created as a result of the construction and operation of 5 dryports. This is only 2.2% more than the business as usual outlook. The direct job losses are significantly less at 33 000 in the 'indicative' year 2032 but, as with the medium and high uptake outlooks this is offset by jobs created through the surplus effect. The breakdown of labour-year type by skills level remains as it is for other outlooks.

Table 17: Low uptake outlook effect on the country's employment

Million labour years	Direct impact	Indirect impact	Induced impact	Surplus impact	Total impact
Total jobs	28	38	53	8	126

5.5 Results summary

5.5.1 Overall impact on employment

The overall impact on employment is shown in Figure 11. The impact is based on the combination of direct, indirect, induced and surplus related labour years. While the number of direct, indirect and induced jobs decreases as the uptake of rail increases, the number of surplus related jobs increases giving a net gain as the rate of uptake of rail freight increases. The line graph represents the grand total employment figures, showing that there is an overall increase in the number of jobs in the broader South African economy.

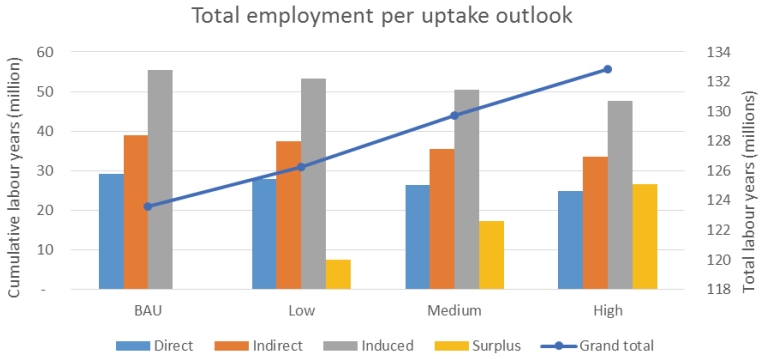


Figure 11: Total cumulative employment per outlook

The trend in terms of changes in jobs is more usefully illustrated as Figure 12 which shows the net job losses in the direct, indirect and induced sectors of the economy due to the freight modal shift, as well as the increase in jobs due to surplus activities in the economy. The line graph represents to positive overall employment trend.

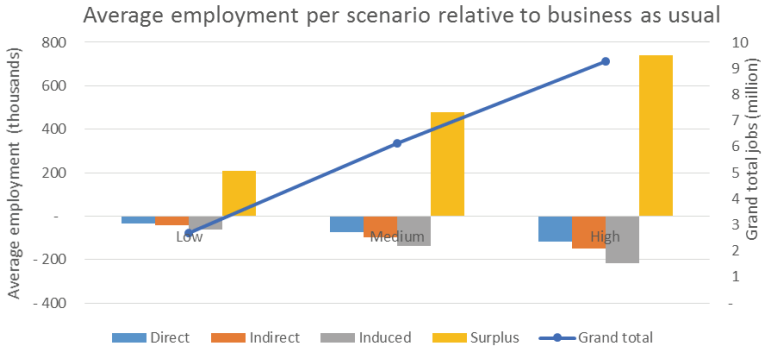


Figure 12: Average employment by freight uptake outlook

5.5.2 Implications for direct jobs

The current level of direct employment in the freight sector is a contentious matter as there is such a wide variety of estimates. For example, the Human Sciences Research Council (2008) and StatsSA (2010) suggest a current employment in the road freight sector in the region of 80 00 to 110 000, whereas SATAWU estimates employment in the road freight sector alone of 300 000. This correlates with the 320 000 trucks in South Africa. In assessing these differences it is possible that they relate to different ways of classifying employment. For example, employment of truck drivers and other positions relating to the operation of trucks may be recorded in the agriculture sector if the workers are employed by farmers or in the retail sector if the workers are employed by retailers. For the purposes of this analysis the official StatsSA figures are used but the fact that this may be well under-estimated needs to be kept in mind.

It is against this background of current employment in the freight sector that the modelled changes in direct employment need to be compared, noting that the direct job losses increase as the freight changes modes. Figure 13 shows the average job losses associated with the three uptake outlooks, as an average over the analysis period with the indicative year being 2032.

[9] *The job losses are also offset to an extent by the increased employment in the rail freight industry, but there is not a linear relationship between the volume of freight moved and the potential employment.*

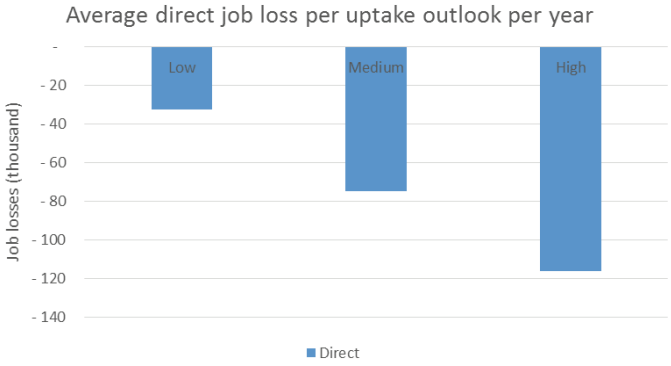


Figure 13: Direct job losses per outlook, in the year 2032

The freight modal transition stimulus is provided mainly to general freight which is moving on corridor routes. This means that any possible job losses will occur on these routes. The estimates show 'average' job losses of 115 000 in the year 2032 in comparison to the business as usual outlook with these estimates related to a change in general freight on corridors only. In this business as usual outlook, the employment in the freight sector (on corridors only) is predicted to be in the region of 169 000 in the year 2032. With a job loss of 115 000 this leaves 54 000 jobs in the corridor based general freight sector. There are currently approximately 121 000 employees in the freight sector (road and rail), of which 81 000 are employed to operate along corridors. The net job losses in road based corridor freight is thus in the region of **27 000** jobs in the year 2032.

It must be noted that this is offset by significantly larger increases in the rural and metropolitan road freight sectors, as well as in the broader South African economy by the surplus effects of the cost savings to the economy[9].

5.5.3 Overall impact on GDP

The overall impact on the country's GDP is positive. There is a contraction of expenditure and thus GDP contribution by sectors which are directly and indirectly related to the transport sector, but the cost savings that are passed on to the consumer have a larger positive effect than the negative effects of a reduction in expenditure. Figure 14 below shows the relative reduction in direct, indirect and surplus contribution to the country's GDP, and the increasing effects

of the surplus that the economy now has as a result of savings. The line indicates an overall increasing contribution to the GDP.

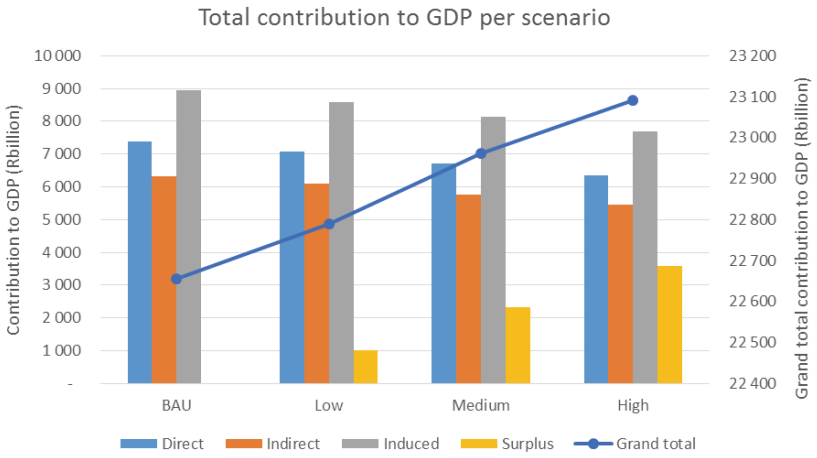


Figure 14: Cumulative impact on the country's GDP by freight uptake outlook

6 Limitations of the study

The exclusion of broader benefits to freight service customers

It is, first of all, necessary to note that the fact that the shift from road to rail is subject to broader business considerations by customers transporting goods through contracts with freight service providers. The evidence indicates that customers are prepared to pay more in terms of direct freight costs as they see other benefits to their business in terms of a faster and more reliable solution. This study has focused primarily on only the freight journey itself, with some provision for 'first and last mile' at each end. It has not attempted to look at the difficult-to-quantify benefits to businesses of lower inventories and service reliability. The most popular business model at the moment uses Just-In-Time principles where there is minimal stock held, thus there is a large value put onto the time taken and reliability of delivery. The analysis presented here does not take this into account. It is unlikely that road freight will move to rail at the levels expected by Transnet unless these factors are adequately addressed.

Externalities

It has been noted earlier that externalities are excluded from this analysis primarily because of the difficulties of analysing their impact in a project of this nature. However, figures are quoted to indicate that externalities favour transport by rail which means that rail is more favourable to the economy that is indicated through the model results. This is grounds for State support for a shift towards rail freight to save the economy as a whole from incurring these 'external' costs.

Static models have limitation in predicting future trends

Socio-economic studies use various techniques to attempt to quantify the economic impact, as well as the social impact of numerous stimuli in the geographic area of study. While these techniques are based on sound empirical and theoretical frameworks, they are rather static in relation to a shifting market. For example, socio-economic studies such as this also do not investigate the potential creation and destruction of new and old industries, which is the market's response to changing circumstances. For instance, new vehicle technology which may be associated with new fuels will generate new industries which cannot be predicted at present.

7 Conclusion

Several conclusions can be drawn from the results presented above.

7.1 Environmental impact

Firstly the importance of the positive environmental impact needs to be re-stated: the Mitigation Potential Analysis undertaken by DEA proved the high priority of the road to rail freight shift from the point of view of movement environmental benefits. Primarily this relates to the fact that rail is more efficient from and energy perspective, per ton.km of freight moved. This translates into a reduction of greenhouse gas emissions which, under the high uptake outlook is estimated to be save 3,000 ktCO_2eq up to and including the year 2050 (0.66% of the total mitigation potential in South Africa).

7.2 Economic

The macro-economic model produces a result which is intuitive: lowering the cost of freight transport in the economy due to a shift from road to rail will lead

improved economic growth prospects. But this happens through various effects as the uptake of rail freight movement increases in proportion to road freight:

- Direct economic activity in the transport sector declines.
- Indirect activity and associated induced impact leads to a decline as the goods and services purchased by the transport sector decrease.
- The forward-linked, surplus effect creates an increase in economic activity in the economy as a whole which is substantially greater than the losses associated with direct, indirect and induced impacts.

It is also notable that the nature of the expenditure does make a difference, as expenditure in different parts of the economy will have different effects, particularly if the expenditure incurred goes out of the country (expenditure on items such as fuel and vehicle purchases are examples of this). Ultimately the total amount of expenditure within the South African economy determines the macro-economic impacts. This implies the obvious: the development of new sources of fuel which requires lower level of imports, greater reliance on local suppliers of other goods and services and improved material beneficiation has the ability to keep the investment in South Africa, thus improving the macro-economic impact of the transport sector expenditure.

7.3 Employment

As is the case for economic impact measures as GDP, the economic modelling shows that the road to rail shift has a positive impact on jobs in the overall economy. However, the positive impact is related primarily to the lowering of freight prices and hence the stimulation of employment in the economy as a whole due to the increased surplus in the economy. Looking only at direct jobs and indirect jobs in backward linked sectors, there are job losses. This depends on which industry the money was spent on within the economy, as well as the relative proportion of that expenditure which is attributable to wages and salaries, tax and operating surplus.

Direct jobs related to corridor based road freight transport include categories such as drivers, assistant drivers, truck mechanics and other logistics and backroom staff. Losses in the backward linked sectors will occur in sectors such as the fuel and manufacture of road freight transport equipment industries. But these are only related to corridor related general freight transport. As other parts of the transport industry, including non-corridor general freight, bulk rail freight and passenger transport, increase this more than compensates for the direct corridor freight job losses.

Most importantly, it needs to be restated that the surplus effects are projected to create significant employment in the country in all sectors. It is not possible to determine which sectors of the economy this surplus effect will occur in, as the money is spent across the full range of economic sectors, there will be more jobs.

Further it should be noted that the high rail freight uptake outlook is quite 'aspirational' and it is far more likely that the reality will be somewhere in the range of the low to medium uptake outlook. The likelihood of job losses in the freight transport sector is, therefore, likely to be much reduced.

Finally, the timeframe over which change will take place needs to be considered in considering the position of workers in the road freight industry engaged currently in corridor based general freight transport. Even taking the high uptake outlook, with estimated job losses, this is a long term impact and will happen gradually. It is, therefore, highly unlikely that workers will need to be entrenched due to a shift of freight from road to rail. It is more likely that the trucking businesses will shift their business to other parts of the transport sector. However, if retrenchment were to happen the economic surplus effect will result in greater job opportunities elsewhere in the economy.

Job loss mitigation measures

Although it has been noted that overall the transport sector will continue to grow with an associated increase in jobs, the projected job losses in the road based, corridor based general freight industry can be considered for very specific attention and it is possible to consider mitigation measures to create employment outside the transport sector. The most obvious of these measures are associated with improved local production of fuel and transport equipment as these sectors are strongly linked to the transport sector. However, it is notable that these measures are likely to be considered by government anyway, regardless of what is happening in the road freight sector as they are part of initiatives to grow the South African economy. They may include:

Supplier development

As mentioned previously, the expenditure which leaves South Africa does not benefit the country's GDP and employment levels, therefore the development of suppliers within the country should be a priority. This includes:

- Construction of rail infrastructure
- Manufacturers of rail vehicles

- Manufacturers of road vehicles (both for freight and passenger vehicles)
- Industries which are involved in the backward linkages of these industries, such as the energy industry where there are many new developments currently.

Passing on of cost savings to consumer

For the economy to benefit from lower freight costs associated with rail, the cost savings (which will be experienced by Transnet as the sole freight rail operator) need to be passed onto the consumer which then brings one of the primary economic benefits of the modal change. It is for this reason that this should be prioritised by the relevant decision makers. If these cost savings are not passed on to the consumer the wider benefits to the economy through 'forward-linked' economic activity will not be realised and then there is likely to be an overall negative impact on both the country's GDP and employment. However, for the purpose of this analysis the assumption is made that lower costs will lead to lower prices for freight transport along corridors, thus highlighting the importance for the State of ensuring that these savings are taken into consideration when assessing rail freight tariffs in the future. Through doing this, there will be greater economic benefits resulting through the multiplier effect.

Supporting the transport sector as a driver of the economy

Rather than see the negative possibility of job losses in the transport sector the much more important positive impact on the economy as a whole of an effective transport sector should receive attention. By increasing investment in transport infrastructure and the sectors serving it, the spin-off for the economy as a whole, including jobs, is substantial. This can occur at the same time as making the cost of freight transport lower.

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